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EFFECT OF PACKINGHOUSE TREATMENTS, TEMPERATURES IN TRANSIT AND CONTAINERS ON DECAY IN TANGERINES.

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Introduction

Although tangerines have been grown throughout the citrus belt of Florida for well over half a century, few, if any publications based on concrete evidence have been issued to shippers of this fruit for their guidance in the selection of the most feasible decay inhibitors and protective service during the transit period. Yet it is common knowledge that the tangerine, a very tender fruit, is easily bruised when ripe and is especially susceptible to green mold decay during the marketing period. Recognizing the dearth of information on the handling and transportation of tangerines, the Florida Tangerine Cooperative formed in the 1950-51 season to extend the market for this fruit, requested the Bureau of Plant Industry, Soils and Agricultural Engineering to conduct holding and shipping tests with tangerines for the purpose of:

1. Appraising the value of the decay inhibitors presently available to shippers, and
2. Comparing the different in-transit protective services used in rail shipments.

This report, based for the most part on tests conducted during the season of 1950-51, also includes a few holding and shipping tests conducted previously but not heretofore reported to the industry as a whole. The holding tests were planned to determine the rate of decay development as influenced by:

1. Low temperatures,
2. Decay inhibitors applied before the fruit is packed,
3. Crate liners or cartons treated with diphenyl, a compound that slowly gives off fumes which check the growth of a wide range of rot producing fungi.

MATERIALS AND METHODS

The fruit used in evaluating antiseptic dips was obtained from packing-houses either immediately after the commercial application of wax emulsion containing a decay inhibitor, or before it was given any treatment. The latter samples were brought to the laboratory in Orlando, passed over a miniature washer, inspected, and only the fruit badly damaged in harvesting was removed before the decay inhibitor was applied.

A fairly large number of holding tests were made at Orlando in which commercially graded and packed fruit was used. This fruit was packed in wirebound crates or in cartons treated with diphenyl, a decay inhibitor. These collections were selected at random from a rather large number of packinghouses and should therefore be representative of fruit going to market at that time, hence they contained their share of bruised or "puffy" fruit. While some were held continuously in a 70°F. holding room with a relative humidity ranging from 88 percent to 92 percent, others were held for varying lengths of time at 38° or 50° at a relative humidity of about 90 percent and then transferred to the 70° holding room. At the first inspection, the fruit was removed from its original container (if carton or wirebound crate), inspected and placed in a small field lug for future inspection. The time interval between setting up the tests and making the first inspection varied from five to ten days to simulate transit periods, a second inspection was made 3 days later when possible, and the final inspection was made one week after removal from the refrigerated rooms.

The shipping tests were made with loads going to market under normal conditions of handling and transportation. The shipping tests were planned to show the comparative rate of cooling obtained from the contrasted protective services and the amount of decay that may be expected to develop during and after the transit period. They also included shipping tests with fiberboard cartons as a partial load with standard nailed crates and diphenyl-treated crate liners and blankets in wirebound crates in comparison with similar fruit packed naked in such crates and loaded in the same car. The test packages were representative samples of the lading and except where noted were placed along the center line of the car at the bottom bunker, middle quarterlength, and top quarterlength positions of the car. At time of packing, a small recording thermometer was placed in the center of each test package in order to obtain a continuous record of the temperatures at each level in the car during the transit period. The fruit in the test crates was from the same grove and was strictly comparable. It was examined critically at time of unloading and whenever possible a general inspection of the load was made. In the shipments to New York or Chicago the test packages were held after arrival at room temperature and relatively low humidity for a week and then a final inspection was made.

HOLDING TESTS IN FLORIDA

Effect of unpacking fruit while wet on decay

There is a popular belief among fruit-men that citrus fruits should not be unpacked while wet with condensed moisture such as occurs when cold fruit is unloaded from cars or transferred from a cold room to a warm one. It is claimed by the industry that handling at such times bruises tangerines and accelerates development of decay.

In order to obtain evidence on this point, one crate of commercially-packed tangerines was stored at 70°F. and two were stored at 38°. After five days all three crates were inspected and then all were stored at 70° for 7 more days after which they were inspected a second time. Af the first inspection one of the crates from the 38° room was inspected immediately while the fruit was still wet with water of condensation while the other was not inspected until the fruit had become dry. This test was repeated twice and the results are summarized in Table 1.

Less than 2 percent rind breakdown developed in any crate. In the crates held continuously at 70°F., there was 10 percent decay, mostly green mold, after five days, and 27.1 percent decay after seven more days. There was only .2 percent decay in the lots that were stored five days at 38° at the first inspection, but after holding one week at 70°, decay had increased to 28.6 percent in the boxes that were inspected the first time while the fruit was wet, and 24.8 percent in the lots that were dried before being inspected the first time, a difference of 3.8 percent. This difference was small and not consistent enough between treatments to be statistically significant. What appeared important from a practical standpoint was that approximately the same amount of decay, largely green mold, was found in all treatments after holding one week at 70° which indicated that the effect of refrigeration at 38° for five days was lost soon after the tangerines were moved to a warm room.

Stem-end rot was beginning to show up in moderate quantity at the end of the 7 days holding period.

Time and temperature in relation to decay

A series of eight holding tests simulating transit periods was made in which commercially graded and packed U.S. No. 1 tangerines were stored at 38° for five and ten days respectively, and then transferred to a 70° holding room for one week. For comparison, a like number of lots were held continuously at 70°. The results are given in Table II. At the first inspection there was 2.1 percent rind breakdown in the fruit held at 70°F. and 1.4 percent and 0.9 percent in that held for five and ten days respectively at 38°.

In the lots held at 70° continuously, 13.4 percent rot developed in five days, and one week later it had increased to 34.1 percent. In the lots stored at 38° for five and ten days, there was only 0.3 and 0.5 percent decay at the first inspection, but during the following week at 70°, all decay had increased to about the same amount as in those held continuously at 70°. In a few individual crates in each grouping there was more than 50 percent decay, largely green mold, at the second inspection which indicated a wide difference in keeping quality of commercially packed tangerines, and that the retarding effect of low temperatures on decay had disappeared within a week after transferring the fruit to room temperature.

Rate of spoilage after removal to room temperatures

Inasmuch as it has been shown that tangerines will not keep a week after removal to room temperature from a simulated refrigerated shipment, a series of 6 holding tests was made in which the second inspection was made after 3 days at 70°F. instead of 7 days, to see if the fruit would keep 3 days at room temperature. A third inspection was made 4 days after the second. The results are summarized in Table III. In the fruit held continuously at 70°, 16.5 percent decay had developed in five days, 27.3 percent three days later, and 40.1 percent in another four days.

There was 0.4 percent decay after simulated shipment for five days at 38°F., only 8.3 percent three days after removal to the 70° holding room, but after seven days at 70° there was 24.4 percent which is approximately the same as in the fruit continuously at 70°. Development of decay in the lots held for a ten day simulated shipping period at 38°, was similar to that in the lots held at 38° for 5 days. Again a very large proportion of the rot was caused by green mold. It was shown by these tests that decay in 3 days was only about one-fourth or one-fifth as extensive as it was 7 days after removal from cool temperatures. It would appear that good refrigeration in transit and prompt use of tangerines within a few days after arrival would be desirable.

Effect of wirebound crates and diphenyl-treated cartons on decay

It is generally recognized that low temperatures inhibit decay only so long as the commodity is under refrigeration and, that spoilage may develop soon after the commodity is brought to room temperature. Therefore it seemed desirable to explore the merits of chemical decay inhibitors, such as diphenyl, that slowly volatize from treated wrapping tissues or paper liners in the shipping package. Diphenyl has been effective in retarding decay in oranges when impregnated in crate liners or fiberboard cartons.

Commercially graded U.S. No. 1 tangerines were packed naked and stored in both wirebound crates and in cartons treated with Phenodor X (diphenyl) treated cartons for one and two weeks at both 50° and 38°F. At the end of the storage period the test lots were transferred to a 70° holding room where the fruit was inspected, the original packages discarded and the test fruit reinspected three and seven days later. This series was repeated twice and the results are summarized in Table IV.

There was not enough rind breakdown in any of the lots to be of commercial significance.

The amount of decay differed but little between fruit packed in untreated crates and that packed in diphenyl-treated fiberboard cartons stored at the same temperature. As an example, after one week at 50°F., there was 6.5 percent decay in the untreated lot and 6.4 percent in the phenodor-treated carton. After three days at 70° rots had increased to 16.4 percent and 16.48 percent respectively, and four days later all rots had risen to 32.8 percent and 36.5 percent. Two weeks storage at 50° resulted in excessively high decay in both treated and untreated packages. Storage at 38° was effective in keeping decay in check, and the fruit from this temperature had much less decay 3 days after removal than that stored at 50°F. After a week at 70° decay was so great in both lots to make them practically worthless. The phenodor box had no effect on decay development either during storage or after removal.

Effect of ventilated and non-ventilated cartons on decay

A series of five tests was made to compare the amount of decay developing in commercially graded U.S. No. 1 tangerines in wirebound crates and ventilated and non-ventilated diphenyl treated cartons. The ventilated phenodor cartons, had 36 half-inch perforations uniformly spaced in the ends and sides. The test lots were stored for two weeks at 50°F., inspected and transferred to crates in a 70° room after discarding the original container and they were re-inspected three and seven days later. The results are given in Table V. Rind breakdown was not affected by the treatments. Practically all of the decay found at the first and second inspection and most of it at the third inspection, was caused by green mold although stem-end rot was beginning to show up in quantity at the final inspection. In the wirebound crates there was 11.6 percent decay at the first inspection; 17.7 percent decay three days later; and 31.7 percent four days after the second inspection.

In the non-perforated phenodor cartons there was 13.7 percent, 22.3 and 34.8 percent decay at the first, second, and third inspections respectively.

The least amount of rot, viz. 9.2 percent, 13.9 percent, and 26.8 percent on the three successive inspection dates, was found in the lots stored in perforated phenodor cartons. The amount of decay in the perforated cartons was consistently less than in the non-perforated cartons in each of the five tests.

Effect of water-soluble decay inhibitors on rind breakdown, chemical injury and decay

Water-soluble decay inhibitors have been in use on citrus fruits close to half a century with varying success on the different kinds of decay.

During January and February, 1951, a comparison was made of two easily applied water-soluble decay inhibitors, viz. "Steriseal", a proprietary compound, and Dowicide A (sodium o-phenylphenate) plus hexamine. The treated fruit was packed in two ways--in wooden crates without diphenyl and in diphenyl-treated fiberboard cartons. "Steriseal" was used at a concentration of 1 part to 19 parts of water, whereas, Dowicide A plus hexamine was used at the rate of 2 percent Dowicide A and 1 percent hexamine.

Solutions of both the "Steriseal" and the Dowicide A - hexamine mixtures were applied for two minutes at room temperature. The treated fruit was allowed to dry without rinsing and was then placed in wooden crates or diphenyl-treated cartons and held for three weeks at 70°F. with inspections made weekly. The cartons were discarded after the first inspection and the fruit placed in wooden crates. The results of eight of these holding tests with fruit from widely separated groves are summarized in Table VI. Since less than 1 percent rind breakdown was observed at both the first or second inspections, it seems safe to conclude that the treatments caused but little if any rind injury.

As in the other tests, a large proportion of the decay that developed within two weeks after treatment was caused by green mold.

In the untreated checks there was 16.7 percent decay after one week, 30.8 percent after two weeks and 52.0 percent after three weeks.

Steriseal held decay to about one half that occurring in the checks at each of the three inspections. The Dowicide-hexamine mixture was even more effective in reducing decay than Steriseal.

The use of phenodor cartons with Dowicide-hexamine treated fruit did not further reduce decay. The percentagewise control from both Steriseal and Dowicide plus hexamine decreased during the holding period, yet the two water-soluble compounds gave sufficient control to warrant their use.

Decay inhibitors in wax emulsions

Previous publications have shown that decay inhibitors such as 2-Amino-Pyridine and Dowicide A, when incorporated in the water phase of wax emulsion, are effective in checking decay in citrus fruits. Doubtless there are other decay inhibitors that can be applied in that manner.

Stine wax, a proprietary wax emulsion containing an undesignated decay inhibitor, was used on tangerines and oranges commercially during the season of 1949-50. The decay retarding properties of this product were tested on tangerines and oranges. The oranges were included in these tests for the purpose of throwing light on the general citrus decay problem.

The fruit was collected at two points in the packinghouse processing line between the washer and drier:

1. Just before the washed fruit reached the dip tank containing the wax emulsion, and
2. Immediately after the fruit emerged from this treating tank.

Samples of fruit from nine groves were taken over a period of two weeks in December. The test lots were brought to the laboratory at Orlando, held at 70° for three weeks and inspected at intervals of seven days. The results are summarized in Table VII.

The results indicate that the wax treatment slightly increased rind breakdown in all lots of fruit. The results further indicate that the decay inhibitor incorporated in this wax emulsion had little if any effect on either stem-end rot or green mold in either tangerines or oranges. It appears from these results that the unnamed decay inhibitor in Stine Wax emulsion is of little value against stem-end rot and green mold of tangerines and oranges.

SHIPPING TESTS

Most of the shipping tests reported herein were made with wirebound crates during the season of 1950-51. A few earlier tests in which fiberboard cartons were compared with crates and crates with diphenyl-treated liners or blankets for decay control were compared with naked pack in crates are also included. The cartons as well as the crates were of 4/5-bushel capacity.

Ventilation in a non-fan car

WFE 67837, a non-fan car, was loaded in Seminole County, December 20, 1950, with 861 wirebound crates of tangerines and shipped to New York where it was unloaded during the early morning hours of December 26. This car was billed to receive no ice, vents to be kept open to Potomac Yards, Virginia, and to be converted there to standard ventilation. A continuous record of the temperature within the crates of fruit was obtained from recording thermometers placed in crates in the top quarterlength, and bottom bunker positions in the forward end of the car.

The outside air temperature during the transit period was from 8 to 15 degrees F. below normal during the first two days, slightly above normal the third day, and followed by slightly subnormal temperatures.

The commodity temperature, figure 1, averaged 62°F. when the car was loaded and the range at unloading was between 33° and 39°. The bottom of the load cooled at a uniform rate to about 35° by noon of the second day and by that time the temperature in the top of the load had been lowered to 52°. During the remainder of the transit period there was little change in temperature in the bottom of the load. The record of the top layer shows fairly fast cooling until about the third midnight after loading when the thermograph's clock failed. Three days later when the car was unloaded this thermograph registered 39°. The maximum spread in temperature between the top and bottom layers was about 17 degrees recorded at about noon of the second day after loading and was gradually reduced to 6 degrees at unloading.

There was no skin breakdown, and only 1.4 percent decay in the test packages on arrival. After one week at room temperature, decay, almost all green mold, had increased to 10.0 percent but there was no increase in rind breakdown.

Ventilation compared with initial icing plus one re-icing in fan cars

The two cars in this comparision, Figure 2, were loaded in Seminole County January 5, 1951, each with 880 wirebound crates of tangerines and with the fans sealed "ON".

One car, WFE 71218, with a few hundred pounds of old ice in the bunkers, was billed vents open to Potomac Yards, standard ventilation beyond, while the other, ART 27995, was initially iced with 10,000 pounds at Sanford at 7:00 A.M. the morning after loading, re-iced with 4,000 pounds at Florence, S. C. 22 hours later, and converted to standard ventilation from Potomac Yards to destination. The bunkers were half full of ice when this car was unloaded 35 hours after re-icing.

During the transit period these cars were exposed to outside air temperatures that ranged from 10 to 14 degrees above normal during the first 2 days of the transit period and as much as 10 degrees below normal (i.e., below freezing), throughout the third day.

There was a considerable range in commodity temperature at time of loading; however, little change occurred before midnight when the cars started their northward movement. The commodity temperature in the test crates at the start ranged from 66° to 75°F. and averaged 70° in the car under ventilation and the unloading temperature ranged from 50° to 54°. In the iced car, the fruit temperatures ranged from 71° to 82° with an average of 76° at midnight of the day of loading, and at unloading ranged from 42° to 44°. The second midnight after loading the temperature in the uniced car ranged from 65° to 69° with an average of 67° and the temperature in the iced car ranged from 57° to 66° with an average of 60°. Thereafter, the load in the iced car was about 10° cooler than that in the non-iced one with a somewhat narrower range in the former.

Inasmuch as both cars were converted to standard ventilation about the third midnight after loading, it is interesting to note that the car without ice cooled at about the same rate as the iced car, thus indicating that the ice in the bunkers did not accelerate cooling after conversion to ventilation. In the uniced car the top layer was the warmest part of the load until the second midnight after which the middle layer was warmest. In the iced car the middle layer was the warmest throughout the trip.

Inspection at New York the fourth day after loading, showed that the test packages in the uniced car averaged 1.5 percent decay, while those in the iced car averaged 1 percent. A week later decay had increased to 11 percent and 5.2 percent respectively. Practically all of the decay was green mold. The greater amount of decay that developed in the lots from the car without ice probably was due to the higher temperatures in transit during the greater part of the transit period.

The effect of delay en route on temperature reduction in fan cars

A pre-iced fan car WFE 73174, was loaded in Orange County with warm fruit on December 18, while a similarly iced fan car, WFE 72222, was loaded the next day with fruit from the same locality but not from the same grove (figure 3). The first car was precooled with Preco fans for seven and one-half hours after loading, while the latter was precooled six hours. Both cars with fans sealed in the "on" position were shipped under standard refrigeration, the former was diverted to Chicago, the latter went direct to New York, and the two cars were unloaded seven and six days respectively after loading. The Chicago car was held at Albany, Georgia, for slightly over one day, while the New York car went through to destination on schedule.

No thermographs were placed in the bottom layer of either car. During loading, the fruit in the former car averaged 55.4°F. and the commodity temperature at both the top and middle of the load was 34° at unloading, while that in the latter car averaged 59.9° at loading and 34° to 37° at unloading. By the first midnight, the fruit temperatures in the warmest part of the Chicago car was below 50° while the temperature in the New York car did not reach that level until the following evening.

By midnight of the day after loading, the temperatures in the top and middle of both cars were closely similar. The warmest part of the non-delayed car reached 40° by midnight of the second day after loading, while the temperature in the delayed car did not reach that level until nearly 24 hours later. The middle of the load was somewhat warmer than the top throughout the transit period in the New York car, and most of the time in the Chicago car. The effect of delay on temperature reduction, that resulted from the nonoperation of the fans during the delay in transit, although not great, can be easily detected on the graph.

The temperature spread between the top and middle layers was narrower, mostly less than 5 degrees, in the Chicago car than in the New York car in which it was 2 degrees or 3 degrees greater.

The condition of the lading in both cars was satisfactory on arrival at their respective destinations. The test packages in the Chicago car had less than 1 percent decay and the New York car 1.4 percent when unloaded seven and six days, respectively, after loading. A week after unloading, decay in these crates had increased to an average of 4217 percent in the Chicago car, and 9.5 percent in the New York car. Practically all of the decay was of the green mold type. This great difference in decay between the two cars could hardly be attributed solely to the slight difference in commodity temperature during the transit period. It seems more likely that the difference was due to the innate keeping quality of fruit from the different groves.

Precooled loads compared with non-precooled loads in fan cars

During January and February 1951, eight-paired carlots of tangerines in pre-iced fan cars were used in shipping tests to determine the effect of precooling. One car of each pair was precooled for six hours with the car fans while the companion car was not precooled. The fan levers of both the non-precooled and precooled cars were sealed in the "on" position by the shipper and the cars were billed standard refrigeration.

One car was diverted to Chicago while the other 7 cars went to New York. By the first midnight, soon after precooling, the top of the precooled loads averaged about 12 degrees cooler than the non-precooled load while the middle layers were only 6 degrees cooler (figure 4). The bottom layers of the non-precooled cars were a few degrees cooler than those of the precooled group. By the second midnight the top of the load in the precooled cars averaged only 7 degrees cooler than that in the non-precooled cars; the middle layer was only 3 degrees cooler; while the bottom positions were practically identical. By the third midnight the average temperatures were almost identical in the two groups of cars in each of the three locations and remained so to destination.

Thus there was a period of about 36 to 48 hours that the top and middle layers of the non-precooled cars were considerably warmer than in the precooled cars. The middle layer was the warmest in both precooled and non-precooled cars except for the first 36 hours after loading when the top layer of non-precooled cars was highest in temperature (figure 5).

At unloading, decay in the precooled test lots ranged from 0 percent to 1.4 percent, averaging slightly less than 1/2 of 1 percent. One week later the range in these test lots was 6.8 percent to 26.5 percent, with an average of 13.8 percent. In the non-precooled test lots decay at unloading ranged from 0 percent to 1.2 percent with an averaged 0.6 percent, while one week later decay ranged 3.4 percent to 17.8 percent with an average of 12.8 percent. Thus when fan cars are used precooling in such cars at shipping point appears to have had no economically significant effect on the amount of decay at unloading or a week later. Practically all of the decay observed in these lots, both on arrival and one week later, was green mold.

Shipping tests to Pacific Coast

Four shipping tests with tangerines in wirebound crates under standard refrigeration were made in January and February, 1951, to the Pacific Coast.

The first transcontinental test shipment of tangerines was made in a pre-iced fan car, ART 28305, with 860 wirebound crates, loaded in Polk County, January 3, 1951, (figure 6). The shipment was precooled six hours with Preco fans after loading and received standard refrigeration en route. The fans were sealed in the "on" position by the shipper and the car was billed to Seattle for partial unloading at Spokane, diverted to Portland, and routed SAL, Md&S, CofGA, IC CMSP&P. The fruit had an average pulp temperature of 67.4 F. when loaded and when unloaded twelve days later the temperature ranged from 32° to 34°. During precooling, the commodity temperature was reduced in the top and bottom of the load more rapidly than in the middle. All parts of the load had cooled to 48° or lower the day after loading, to 39° or below by noon of the third day, and to somewhat below 35° during the second half of the 12-day transit period. At no time in transit was there more than 7- or 8-degree spread in temperature between different parts of the load; usually it was less than 5 degrees (figure 6). This car was serviced with 27,500 pounds of ice of which 5,620 pounds was supplied beyond Birmingham, Alabama, or after the second day en route. The general condition of the fruit was very good on arrival at Portland two weeks after loading. In the test packages, decay averaged approximately 2 percent, mostly green mold.

The second transcontinental test (figure 7) was loaded in Orange County, January 31, 1951, and shipped to Los Angeles via SAL, L&N, SP. This non-fan car, FGE 10931, was loaded with 855 wirebound crates of tangerines with a pulp temperature of 72.9°F. At time of unloading, twelve days later, the temperature range in the load was 35° to 43°. After loading, the car was precooled six hours with a mechanically refrigerated precooling unit placed in the doorway, and the car was initially iced after precooling, and shipped under standard refrigeration.

Excellent cooling was obtained with the mechanically refrigerated unit for the commodity temperatures in the top of the load were reduced about 30 degrees, the middle quarterlength position 25 degrees, and the bottom layer about 15 degrees.

By noon of the day after loading the warmest part of the load was below 50°F. (figure 7). The temperature in the top of the load remained fairly constant between 40° and 45° during the transit period whereas the bottom layer at the bunker which soon became the coldest part of the load reached 35° within two or three-days, and remained at or near that during the remainder of the trip. During transit the temperature in the middle position fell slowly and leveled off somewhat below 40° five days after loading, and maintained a range between 35° and 40°. Thus during the greater part of the transit period, the top of the load was only 6 or 7 degrees warmer than the coldest location. This car was supplied with only 19,600 pounds of ice during the transit period, 13,300 pounds of it east of the Mississippi River.

The condition of the general load at Los Angeles fourteen days after loading was very good with an average of less than 1/2 of 1 percent decay in the main load and 1/2 of 1 percent in the three test packages.

The third transcontinental shipping test, a fan car, FGE 38513, was loaded in Volusia County, January 31, and shipped to Seattle via ACL, Frisco, UP, with a partial unload at Portland. This car was pre-iced, loaded five layers high throughout with 1,010 wirebound crates of tangerines, precooled for six hours with motor-driven Preco car fans and shipped standard refrigeration. After precooling, the fans were sealed in the "on" position.

During loading the tangerines had an average pulp temperature of 70°F. and at the end of the precooling period the top of the load had cooled to 60°, middle to about 64°, and the bottom to 53°. When unloaded, fourteen days later, the fruit temperatures ranged from 33° to 36°.

Throughout the transit period, the middle layer was the warmest part of the load, but the top of the load was only slightly cooler than the middle layer (figure 8). The maximum spread in temperature during the transit period, about 17°F., occurred at about midnight the day after loading before the car had been moving long enough for the fans to have much effect. Then the warmest part of the load was 60°. The following midnight the warmest part of the load was about 50° and there was less than 10 degrees spread in temperature between the warmest and coldest locations. By the seventh day after loading the maximum temperature was below 40° while the minimum hovered around 34° and during the remainder of the trip the maximum temperature was about 36°, with a temperature spread of 4 degrees or less. This car was serviced with slightly more than 32,000

pounds of ice of which 7,200 pounds were supplied beyond Birmingham after the second day en route.

On arrival at Seattle fourteen days after loading, the consignment was in very good condition and was accepted without exceptions. In the test packages decay, green mold, ranged from 0 to 2 percent and averaged less than 1 percent.

The fourth test shipment to the Pacific Coast originated in Polk County, on February 20, 1951. A fan car, SFRD 4328, was loaded with 856 wirebound crates of tangerines and shipped to Tacoma, Washington, to be partially unloaded at Seattle. This car was pre-iced, loaded with partially precooled fruit, routed SAL, MD&S, CofGA, FRISCO, CB&Q, and NP; and shipped under standard refrigeration with fan levers sealed in the "on" position. Part of the load consisted of 210 lightly precooled crates, with an average temperature of 70.7°F. when loaded. The rest of the load consisted of 646 crates that had been precooled 22 hours and had an average temperature of 45.5°. The commodity temperature at time of unloading ranged from 32° to 34°. The cooler crates in the car must have had some effect on the rate of cooling of the test packages during the transit period. During the transit period the top and bottom of this load cooled at about the same rate, however, the middle layer was somewhat slower and remained warmer throughout the ten-day transit period.

The first midnight after loading, the temperature ranged from 51°F. at the bottom bunker position to 65° at the middle quarter-length location (figure 9). Twenty-four hours later, the temperature in the crates ranged from 43° to 53° in the same locations. By noon of the second day after loading the warmest part of the load was below 50° and the coldest part about 37°. From the third day after loading until arrival at destination the commodity temperature was in the 30's, and there was less than 5 degrees spread in temperature between the coldest and warmest location. During the last few days of the transit period the temperatures in these locations ranged from 32° in both the bottom and top locations to 34° in the middle positions. This car was serviced with 29,050 pounds of ice of which 8,150 was supplied west of Birmingham, i.e., after the second day en route.

When this car was unloaded in Seattle the lading was in generally sound condition and the test crates had from 0 percent to 0.5 percent decayed fruits with an average of less than 1/2 of 1 percent. The decay was caused by the green mold fungus.

In view of the relatively small amount of ice supplied these cars west of Birmingham, Alabama, during their transcontinental movement, it may be questionable if standard refrigeration is always necessary when tangerines are shipped in fan cars to distant markets in cool winter months. Although a test shipment with tangerines under rule 251, i.e., initial icing followed by only one re-icing was not made, an opportunity presented itself to get temperature-in-transit records on a transcontinental shipment of grapefruit in wirebound crates. Since grapefruit has a billing weight of 83 pounds per 1-3/5-bushel wirebound crate and tangerines 45 pounds per 4/5-bushel wirebound crate, a 525 load of the former has approximately the same billing weight as a 968 box load of the latter. With loads of grapefruit and tangerines of similar weight, the rate of cooling per ton of ice melted should be approximately the same although the smaller fruit in small packages may cool more rapidly.

This test with grapefruit was made in fan car, FGE 38842. There were a few hundred pounds of old ice in the bunkers when the car was loaded in Polk County on February 22, 1951, with 525 1-3/5-bushel wirebound crates of grapefruit. The fruit was precooled six hours with a platform precooler after loading, and shipped to Los Angeles via SAL, L&N, SP. The car was initially iced early in the morning after loading and re-iced with 7,800 pounds at New Orleans on the third day making the total amount of ice supplied slightly less than 17,400. The commodity temperature when loaded was 61.2°F. and when unloaded eleven days later, it was 35° to 38°. The six hours precooling had but little effect on the commodity in the top or middle of the load, but the old ice in the bunkers cooled the fruit in the bottom location about 10 degrees. Soon after this car was initially iced, the top layer became the coolest part of the load and remained so throughout the trip (figure 10). The middle position was the warmest during the first half of the trip while the bottom was the warmest during the latter half. By midnight of the day after loading the commodity temperatures were 45° in the top of the load and 51° in the middle layer, and they remained in the 40's until the car was re-iced. Thereafter, the temperature ranged mostly between 35° and 40° and when unloaded eleven days after shipment the commodity temperature ranged between 35° and 38°. This test indicated that if the fruit was well precooled one re-icing en route even for long distance shipments, may suffice during the cooler months when tangerines are shipped.

COMPARISON OF CONTAINERS

Inasmuch as interest has been shown by the citrus industry in fiberboard containers for citrus fruits, results obtained several years ago from shipping tests with tangerines in fiberboard containers may be appropriately presented here.

Two shipping tests were made in which tangerines packed in standard nailed crates were compared with perforated, fiberboard cartons of similar capacity. The inside dimensions of the cartons used in the first test were 19-1/8 inches by 9-1/2 inches by 9-1/2 inches. The crates were loaded on end in the rear end of the car in the usual pattern of 8 rows, 3 layers and 20 stacks. The cartons were loaded nine rows wide in six layers, nine stacks long in the "head" or front end of the car, and car strips were placed between each layer. While this was a snug load, it was not tight enough to close all vertical air channels between each row of packages. Car strips were nailed to the crates in the usual manner while cartons were not secured to the strips.

This test was made from Polk County, December 9, 1942, with ethylene-treated tangerines loaded in ART 22507, a non-fan car, and shipped under standard ventilation to New York where it was unloaded five days later. The commodity temperature at loading time averaged 72°F. and at unloading ranged from 42° to 48° in the crates and from 38° to 54° in the cartons (figure 11). The outside air temperatures were within a few degrees of normal until after the car arrived at destination. The fruit in the crates in the top and middle layers cooled at a rather uniform rate of 5 to 8 degrees per day for a total average reduction of about 27 degrees. The top crate was from 3- to 6-degrees warmer than the middle crates during the greater part of the trip. The fruit cooled more slowly in the cartons than in the crates and there was little change in temperature in the top and middle layer until the second midnight after loading. Thereafter, cooling progressed at a rate of about 5 to 6 degrees per day for a total average reduction during the transit period of about 22 degrees in the cartons whereas there was about a 27 degree reduction in the crates placed in similar positions.

The evaluation of decay development was made from a cross section inspection of the general load in each type of container as well as from three test crates, and from a similar number of cartons from each of three groves.

When unloaded five days after loading there was less than 1 percent decay (mostly stem-end rot) in that part of the general load packed in crates and three times that amount in the fruit packed in cartons. There was less than 1 percent total decay, mostly stem-end rot, in test crates and 2.1 percent total decay in the test cartons of which less than 1 percent was green mold rot and the remainder was stem-end rot.

After the test packages were held one week at room temperature decay had increased to 15.1 percent in the crates of which 4.1 percent was green mold rot and the remainder was stem-end rot. At the same time there was 14.0 percent decay in the cartons of which 3.7 percent decay was green mold rot and the remainder was stem-end rot.

A few weeks later standard nailed crates were compared with cubical fiberboard cartons of similar capacity for use with tangerines. In this test the fiberboard cartons had an inside dimension of 12-1/2 inches by 12-1/2 inches by 12-1/2 inches.

For this test, FGE 66469, figure 12, a pre-iced fan car, was loaded in Pasco County, February 10, 1943, and the fan lever placed at the "on" position. The "head" or front end of the car was loaded with fiberboard boxes in seven rows, five layers, and fourteen stacks, thus giving a one-inch space between rows. Two car strips were placed horizontally between each layer where a small block one inch by four inches was tacked to car strips and dropped into place, each separator block making contact with four cartons. The purpose was to separate each box to afford a continuous vertical air channel.

The rear end of the car was loaded with the standard nailed crates placed three high on end with the usual car stripping between each layer in eight rows and twenty stacks.

Immediately after adding 300 pounds of salt to the ice bunkers the car was precooled for six hours with a General American Produce Conditioner, ending during the early morning hours the day after loading. The first re-icing in transit took place in the afternoon the day after loading. The car was shipped under standard refrigeration to New York City where it was unloaded seven days later with bunkers nearly full of ice, soon after a period of subzero weather there.

There was very little difference in temperature between the crates and cartons in the top layer, however, the temperatures in the middle of the load were approximately 8 degrees higher in the fiberboard boxes than in the crates during most of the transit period (figure 12). At the bottom bunker location the crates remained cooler than the cartons by 5 or more degrees.

Although the load was subjected to very low outside air temperature and the bunkers were almost full of ice at unloading, no indication of frost damage was noted in any part of the car.

The tangerines in both cartons and crates, in the commercial load arrived in very fine condition. Decay ranged from 0- to 4-percent, averaging 1.2 percent in the cartons and 1 percent in the crates.

At unloading there was no decay in the test crates and less than 1 percent decay in the test cartons. After one week holding at 70° there was from 15 percent to 19 percent decay in the crates and 15 percent to 16.5 percent in the cartons. Practically all of the decay was green mold.

Two shipping tests in non-fan cars were made with tangerines loaded in Lake County on January 22, 1946, in cars in which most of the lading was packed in wirebound crates. Some crates were lined with diphenyl-treated liners while others had spongy blankets consisting of multi-layers of crepe paper heavily impregnated with diphenyl between each layer of fruit. The first car, SFRD 19262, loaded with 803 crates four and five layers high with an average temperature of 67° was shipped to Jersey City under standard ventilation; the second, PFE 28215 with 855 crates with an average temperature of 66° loaded five high throughout was shipped to Washington, D. C., under standard refrigeration. Unfortunately there was no record of temperatures within the cars during the transit period since no recording thermometers were available for use then.

When the cars were unloaded at destination the car given standard ventilation had an average of less than 1/2 of 1 percent decay in the test crates regardless of treatment. After one week at 70°F., decay in the naked pack check lot averaged 6.6 percent, in the crates with diphenyl-treated liners 11.2 percent, and 3.4 percent in the crates with diphenyl-treated blankets between each layer of fruit. Practically all of the decay was caused by green mold.

An informal inspection of the general load of the car given standard refrigeration was made during unloading by the inspection service. No decay was found in the naked pack, and from 1 to 13 percent green mold in the crates lined with diphenyl-treated paper. In none of the test crates was there as much as 1/2 percent decay on arrival but after holding test packages for one week at 70°F., 7.7 percent decay was found in the naked pack; 8.7 percent in the crates with diphenyl-treated liners; 8.2 percent in the crates with diphenyl-treated liners plus separators, i.e., one sheet of diphenyl-treated Kraft paper per crate; and 6.8 percent decay in the crates with diphenyl-treated blankets between each layer of fruit. Again practically all of the decay that developed during the week after unloading was caused by green mold.

The results of this test lends support to the conjecture that the liners made a rather tight package which probably held a higher relative humidity and also delayed cooling, thereby favoring the development of green mold to such an extent as to counteract the benefits of diphenyl.

DISCUSSION

Perhaps the greatest deterrent to extending the marketing period, wider distribution, and better prices for tangerines is the amount of decay that develops as the fruit ripens. Not infrequently when the fruit is ripe more than 50 percent decay may be expected to develop within a week after the fruit reaches market.

Tangerines are so tender that the skin is easily torn during picking. Likewise, they are so easily bruised that it is perhaps impossible to handle them by present picking and packing methods, without causing considerable injury to the rind and, thereby, paving the way for ready entrance of rot organisms such as the green mold fungus.

Unless radical changes are made in the general direction of careful handling all along the line from tree to table, the shipper and consumer alike may with valid reason expect decay to develop in disastrous proportions within a few days after a shipment of tangerines reaches market. This should be expected even when the fruit reaches market in apparently sound condition. Probably the first corrective step is packinghouse machinery designed especially for tangerines, a commodity which when ripe is almost as tender as a red-ripe tomato or a mellow-ripe peach. The riper the fruit, the more tender it becomes and the greater the amount of decay.

It has long been known that the ethylene treatment for degreening citrus fruits accelerates stem-end rot and reduces green mold decay somewhat, resulting in a net increase in decay. Especially noteworthy was the relatively small amount of green mold and large amount of stem-end rot in the test lots of ethylene-degreened tangerines held at Orlando as well as in the test shipments to auction markets. Green mold accounted for a very large proportion if not practically all of the decay that developed in non-degreened tangerines within a week or ten days after packing, whether held under observation at Orlando or shipped to market. This fungus grows very rapidly at temperatures in the low 70's and under favorable conditions can develop into visible decay within three or four days after the fruit is injured and completely rot the fruit within a week. In retarding decay in tangerines, 50°F. proved to be much less effective than was 38°.

After removal from low temperature there was a margin of about three days before decay had increased excessively. The effect of low temperature on decay was largely spent within one week at room temperature, hence it appears that low temperatures merely retard the development of decay while the commodity is so cool that rot fungi grow slowly if at all. Too often the effect is to pass the burden of decay on to the receivers or consumers.

Certain chemical treatments applied to citrus fruits in packinghouses are capable of checking the development of decay not only during the transit period but for a considerable period thereafter provided the rot organisms have not become deep-seated before the fruit is treated. Such antiseptics as Steriseal and Dowicide-A plus Hexamine applied in a liquid state to fruit before packing were effective in checking rot development, the latter being more effective than the former for a week or two, but neither gave sufficient control.

Decay was not further reduced when Dowicide-A plus Hexamine treated fruit was packed in diphenyl-treated fiberboard cartons, yet diphenyl made its original reputation as an inhibitor of green mold in oranges when the fruit was packed in treated wraps. The failure of diphenyl-treated cartons to control green mold seems to be more likely due to higher humidities in the tight packages rather than to a loss in effectiveness of the chemical.

Shipping tests under standard refrigeration to such distant markets as Los Angeles and Seattle demonstrated that sound delivery of tangerines can be made to markets that are some ten to fourteen days distant. Most of the test shipments were made in cars equipped with Preco car fans. However, one was with a non-fan car that had its lading thoroughly precooled after loading.

Ample evidence has been obtained from shipments of oranges and grapefruit in fan cars during the cooler months to justify the conclusion that Rule 251 i.e. initial and one reicing gives essentially the same temperatures for at least four or five days as standard refrigeration during the period when tangerines are being shipped in quantity. It seems quite probable that initial ice and one re-icing in transit, or initial ice, replenishment after precooling and one re-icing would be adequate for transcontinental shipments of tangerines in fan cars, moving in cool weather.

Sound delivery of both precooled and non-precooled fruit in pre-iced fan cars given standard refrigeration was also made to such markets as Chicago and New York. In these shorter hauls, all in fan cars, precooling after loading did not result in less decay than in non-precooled fruit.

The value of refrigeration in transit in warmer than normal winter weather was demonstrated in the cars shipped to auction with dry bunkers under ventilation when compared with initial icing given after loading and one re-icing en route.

The difference in temperature between loads of cartons and crates may have been due in part to the none too uniform vertical air channels between the rows of cartons. The observed differences in temperature probably were not of sufficient magnitude or duration to single-handedly have had much effect on the carrying quality of tangerines. Doubtless higher humidity prevailed in the cartons thereby serving to expedite the rot organisms.

SUMMARY

Such antiseptics as Steriseal and Dowicide A plus hexamine applied during the washing period, were effective in retarding the usual decay for a week or two after application.

Decay development was as rapid in diphenyl-treated cartons as in naked-packed wirebound crates.

Based on holding tests, at Orlando as well as at auction markets, the receiver has about three days in which to dispose of his fruit before decay becomes excessive. In a week after unloading, the beneficial effects of low temperatures during transit were largely spent.

Precooled tangerines shipped in fan cars under standard refrigeration as far as Seattle and Los Angeles arrived there from ten to fourteen days later in sound condition. Both precooled and non-precooled tangerines in fan cars reached New York in sound condition. Decay developed rapidly in tangerines after they reached market.

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Table I
EFFECT OF
HANDLING TANGERINES WHILE WET WITH CONDENSED MOISTURE ON SUBSEQUENT DEVELOPMENT OF RIND BREAKDOWN AND DECAY

JANUARY AND FEBRUARY - 1951

Average of 2 tests

Initial Storage	Condition at first inspection	No. Fruits	FIRST INSPECTION After 5 days storage					SECOND INSPECTION After 7 days at 70°F.			
			RB	DK	SER	GM	MISC	DK	SER	GM	MISC
			Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
5 days at 70°F.	Dry	560	1.1	10.2	0.9	8.7	0.5	27.1	5.5	19.8	1.8
5 days at 38°F.	Wet 1/	559	0.2	0.2	0.2	0	0	28.6	4.5	18.4	5.7
5 days at 38°F.	Dry 2/	560	1.8	0.2	0	0	0.2	24.8	2.5	19.8	2.5

1/ Inspected immediately after withdrawal from low temperatures. Heavy deposit of moisture on fruits at time of inspection.

2/ Inspected after fruit had warmed and dried.

Key:

RB signifies Rind Breakdown - (total of Age. Pits and Wilts)
DK signifies total Decay
SER signifies Stem End Rot - Phomopsis or Diplodia
GM signifies Green Mold or Penicillium Rot
MISC signifies Miscellaneous Rots

Note: Because of similarity in appearance during the early stages of development of decay, the types of rots could not be accurately diagnosed. It seems safe to conclude that practically all of the decay that developed within 1 week at 70° was caused by Penicillium and much of the decay catalogued as stem end rot at the second inspection was caused by Penicillium within the stem area.

Table II

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN COMMERCIALLY PACKED U.S. NO. 1 TANGERINES STORED FIVE AND TEN DAYS AT 38°F.

January and February - 1951

Average of 8 tests

Initial Storage	No. Fruits	FIRST INSPECTION After 5 days storage					SECOND INSPECTION After 7 days at 70°F.			
		RB	DK	SER	GM	MISC	DK	SER	GM	MISC
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
5 days at 70°F.	1484	2.1	13.4	4.1	7.5	1.8	34.1	8.1	22.6	3.4
5 days at 38°F.	1484	1.4	0.3	0	0.3	0	38.3	3.1	32.5	2.6
10 days at 38°F.	1475	0.9	0.5	0.1	0.4	0	35.5	5.4	26.2	3.9

Key: See table I.

Table III

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN COMMERCIALLY GRADED AND PACKED U.S. NO. 1 TANGERINES AFTER STORAGE AT 38° AND 70°F. AND AFTER 3 AND 7 ADDITIONAL DAYS AT 70°F

JANUARY AND FEBRUARY - 1951

Average of 7 tests

Initial Storage	No. Fruits	FIRST INSPECTION After 5 or 10 days in storage					SECOND INSPECTION After 3 days at 70°					THIRD INSPECTION After 7 days at 70°			
		RB	DK	SER	GM	MISC	RB	DK	SER	GM	MISC	DK	SER	GM	MISC
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
5 days at 70°F.	1164	2.3	16.5	4.6	10.0	1.9	1.1	27.8	5.6	19.6	2.7	40.1	8.7	27.1	4.3
5 days at 38°F.	1374	1.0	0.4	0	0.4	0	2.1	8.3	1.2	5.5	1.6	42.4	4.7	32.8	4.8
10 days at 38°F.	1303	1.1	0.5	0.1	0.4	0	2.1	8.1	2.7	2.8	2.6	37.8	6.1	27.3	4.3

Key: See table I.

Table IV

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN U.S. NO.1 TANGERINES STORED ONE AND TWO WEEKS AT 50° AND 38°F. IN WIREBOUND CRATE AND PHENODOR X TREATED CARTONS.

JANUARY AND FEBRUARY - 1951

Average of 3 tests

Type of box and storage temperature	No. Fruits	FIRST INSPECTION After 1 or 2 weeks storage					SECOND INSPECTION After 3 days at 70°					THIRD INSPECTION After 7 days at 70°			
		RB	DK	SER	GM	MISC	RB	DK	SER	GM	MISC	DK	SER	GM	MISC
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
50° - 1 week															
Wirebound	629	0.5	6.5	3.0	2.2	1.3	0.3	16.4	5.1	9.1	2.2	32.8	6.7	21.8	4.3
Phenodor X	597	1.2	6.4	2.5	3.5	0.3	0.1	16.8	5.9	9.2	1.7	36.5	8.4	24.5	3.7
50° - 2 weeks															
Wirebound	594	0	21.7	1.7	18.4	1.7	0.2	32.0	2.5	26.9	2.5	59.8	8.2	47.3	4.2
Phenodor X	597	1.5	26.8	2.7	19.9	4.2	1.7	38.7	4.0	30.0	4.7	56.6	6.9	43.9	5.9
38° - 1 week															
Wirebound	634	0.5	1.6	0.8	0.3	0.5	0.3	8.8	3.0	3.2	2.7	45.0	4.3	35.8	4.9
Phenodor X	596	0.3	0.8	0.3	0.2	0.3	0.3	8.7	3.7	2.0	3.0	42.1	5.4	32.6	4.2
38° - 2 weeks															
Wirebound	626	2.2	3.4	1.0	0.5	1.9	3.2	12.1	1.1	8.5	2.6	38.2	1.8	33.1	3.4
Phenodor X	595	0.5	2.7	0.8	0.8	1.0	2.4	15.3	2.0	11.9	1.3	36.8	3.0	31.3	2.5

Note: Original container discarded at first inspection.

Key: See table I .

Table V

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN COMMERCIALLY GRADED U.S. NO. 1 TANGERINES PACKED IN VENTILATED AND NONVENTILATED PACKAGES DURING TWO WEEKS IN STORAGE AT 50°F

FEBRUARY AND MARCH - 1951

Average of 5 tests

Container	No. Fruits	FIRST INSPECTION After 2 weeks at 50°					SECOND INSPECTION After 3 days at 70°					THIRD INSPECTION After 7 days at 70°			
		RB	DK	SER	GM	MISC	RB	DK	SER	GM	MISC	DK	SER	GM	MISC
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
Wirebound Crate	891	8.2	11.6	0.3	11.2	0	8.0	17.7	1.9	15.3	0.6	31.7	8.5	21.1	2.1
Phenodor X Carton	903	8.3	13.7	1.0	12.4	0.3	5.2	22.3	1.1	20.6	0.6	34.8	4.8	28.7	1.3
Perforated Phenodor X Carton	890	9.4	9.2	0.3	8.7	0.2	8.9	13.9	0.8	12.4	0.8	26.8	5.4	20.3	1.1

Key: See table I.

Table VI

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN TANGERINES TREATED WITH WATER SOLUBLE DECAY INHIBITORS

JANUARY AND FEBRUARY - 1951

Average of 8 tests

Treatment	No. Fruits	FIRST INSPECTION (1 week at 70°)						SECOND INSPECTION (2 weeks at 70°)						THIRD INSPECTION (3 weeks at 70°)			
		RB	CI	DK	SER	GM	MISC	RB	CI	DK	SER	GM	MISC	DK	SER	GM	MISC
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
Check (No Treatment)	1513	0.2	0	16.7	2.2	14.1	0.4	0	0	30.8	5.9	24.2	0.7	52.0	19.4	31.7	0.9
Steriseal	1487	0.8	0	6.5	1.8	4.0	0.7	0.1	0	16.9	3.3	12.3	1.3	26.1	5.9	18.4	1.7
2% Dowicide A+ 1% Hexamine	1495	0.7	0	2.9	1.1	1.1	0.7	0	0	10.9	2.9	6.4	1.7	23.2	7.2	12.7	3.3
2% Dowicide A+ 1% Hexamine, in Phenodor Cartons	1408	0.5	0	3.2	0.8	1.9	0.5	0	0	11.0	2.2	7.5	1.3	24.6	8.7	12.6	3.2

Key:

RB signifies Rind Breakdown - (total of Age, Pits and Wilts)
CI signifies Chemical injury
DK signifies Decay
SER signifies Stem End Rot
GM signifies Green Mold or Penicillium Rot
MISC signifies Miscellaneous Rots

Table VII

DEVELOPMENT OF RIND BREAKDOWN AND DECAY IN TANGERINES AND ORANGES TREATED WITH STINE WAX EMULSION APPLIED IN PACKINGHOUSE

DECEMBER - 1949

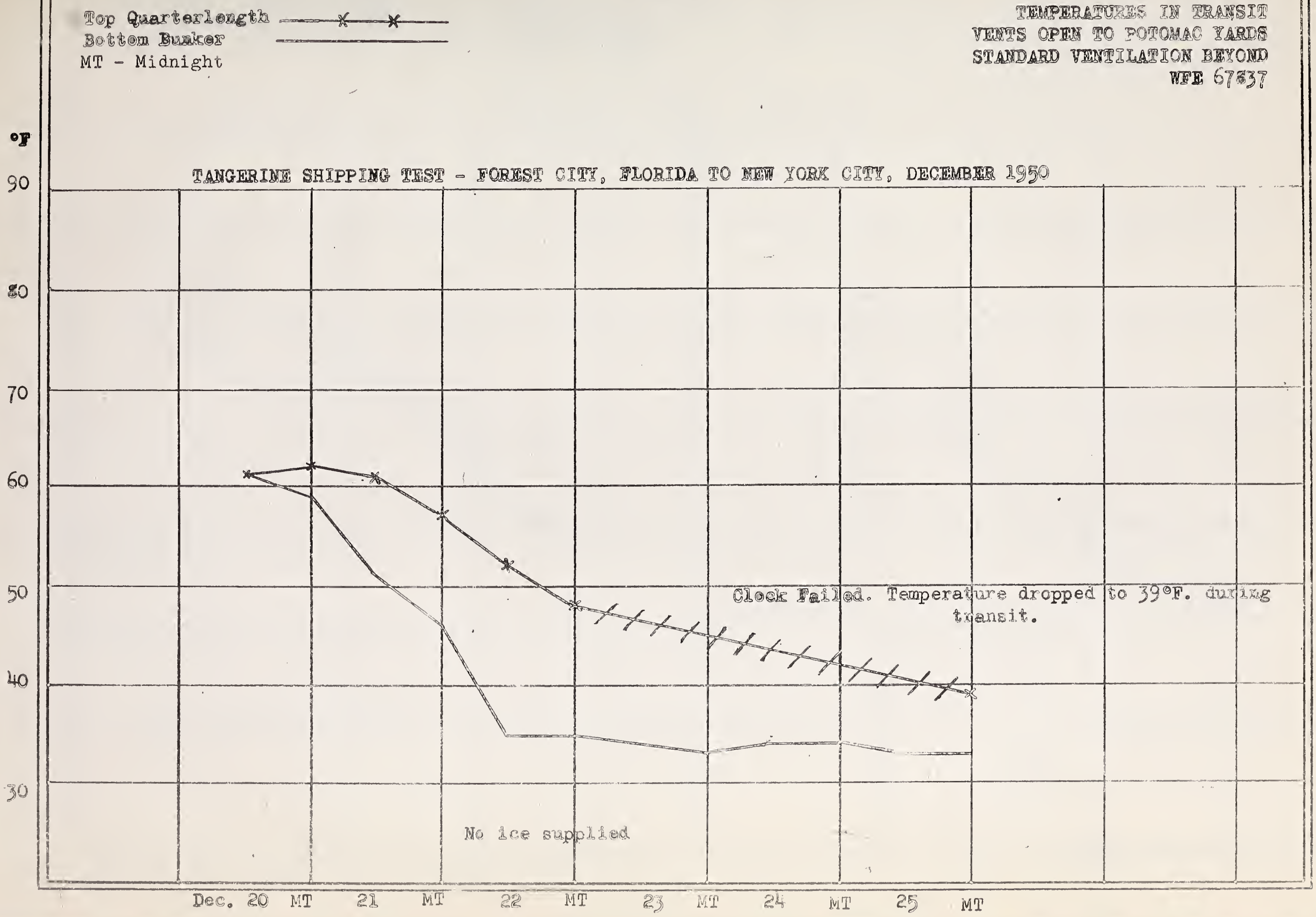
Average of 9 tests

Fruit	Treatment	No. Fruits	1 week at 70°					+ 1 week at 70°				+ 1 week at 70°			
			RB	DK	SER	GM	MIS	DK	SER	GM	MIS	DK	SER	GM	MIS
			Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct
Tangerines 1/	Washed only	1052	1.8	8.5	0.7	7.4	0.4	27.4	13.9	12.4	1.1	48.4	30.0	16.8	1.5
do 1/	Washed and Waxed	1024	3.2	7.3	1.4	5.9	0.1	28.8	15.6	11.5	1.7	52.6	34.5	15.4	2.7
Oranges 2/	Washed only	990	0.4	6.5	0	5.4	0.9	22.5	6.5	14.8	1.2	42.1	14.4	25.6	2.1
do 2/	Washed and Waxed	977	0.6	6.6	0.6	4.9	1.0	24.9	8.3	13.8	2.8	45.9	23.6	18.9	3.3
Oranges 1/	Washed only	841	1.7	8.1	5.8	1.3	1.0	63.0	56.6	4.9	1.5	78.4	70.6	5.7	2.0
do 1/	Washed and Waxed	971	3.3	7.4	4.9	1.0	1.4	66.0	59.5	4.6	1.9	80.6	71.3	6.8	2.4
Oranges 3/	Washed only	1100	23.1	7.5	3.8	2.5	1.2	52.4	44.2	6.4	1.8	69.5	56.2	11.2	2.2
do 3/	Washed and Waxed	1021	37.4	4.6	1.5	2.7	0.4	49.3	40.4	7.9	1.0	66.2	53.4	11.6	1.3

1/ Subjected to usual ethylene treatment.
2/ Not subjected to usual ethylene treatment.
3/ Subjected to usual ethylene treatment and color added treatment.

Key: See table I.

Figure 1



TANGERINE SHIPPING TEST - FOREST CITY, FLORIDA TO NEW YORK CITY, DECEMBER 1950

TEMPERATURES IN TRANSIT
VENTS OPEN TO POTOMAC YARDS
STANDARD VENTILATION BEYOND
WFE 67637

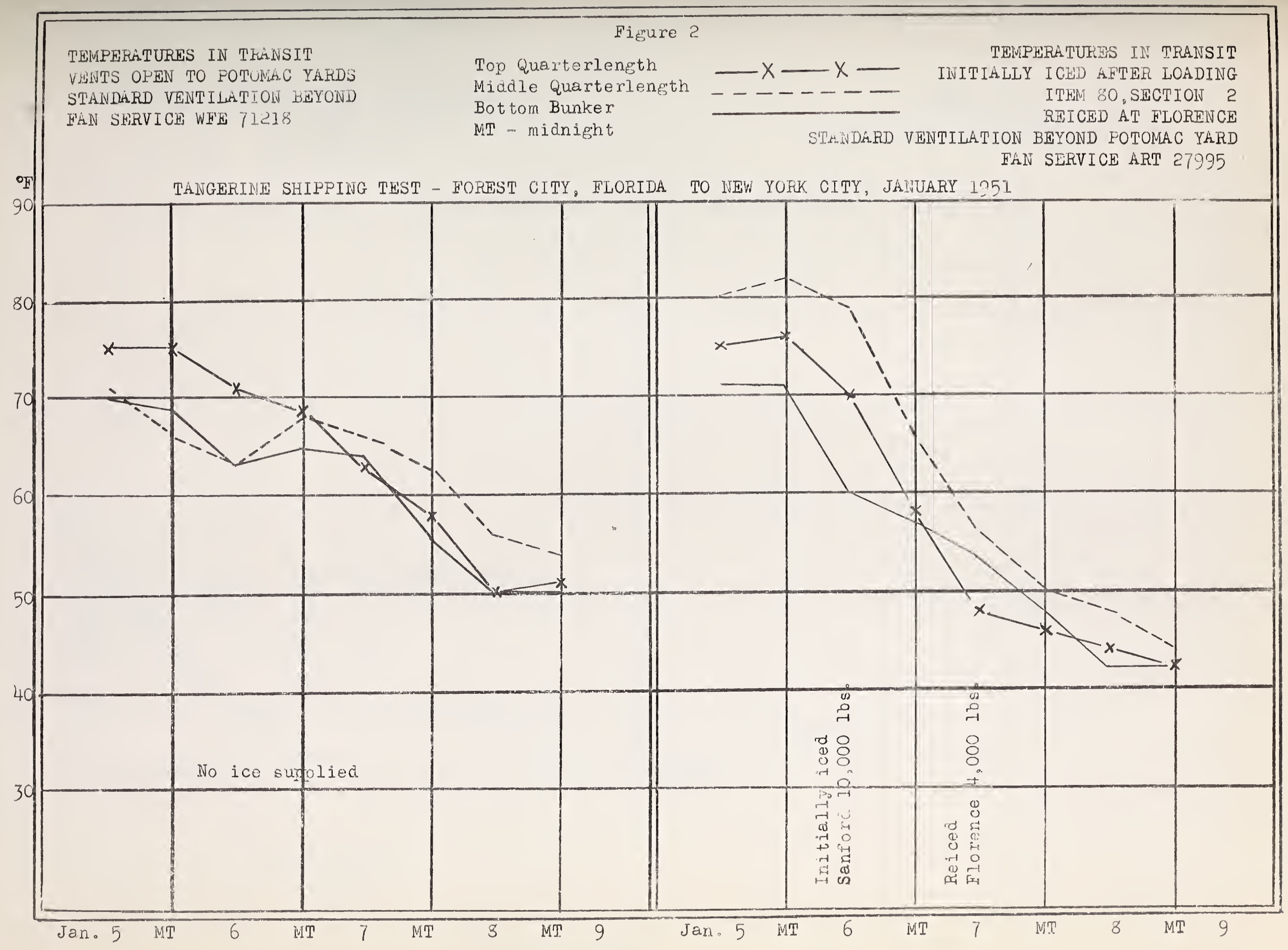
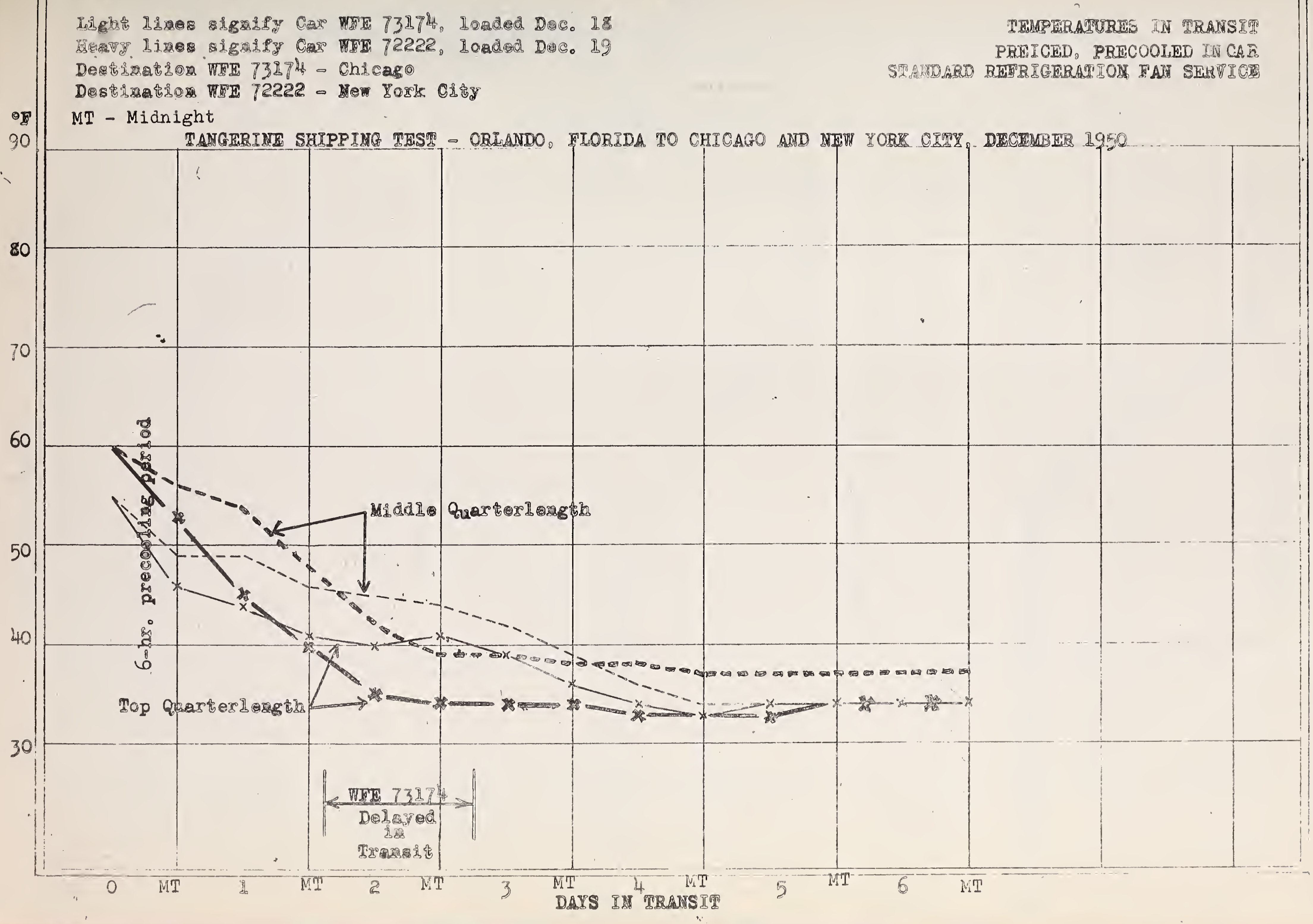


Figure 2

TANGERINE SHIPPING TEST - FOREST CITY, FLORIDA TO NEW YORK CITY, JANUARY 1951

Figure 3



Light lines signify Car WFE 73174, loaded Dec. 18
Heavy lines signify Car WFE 72222, loaded Dec. 19
Destination WFE 73174 - Chicago
Destination WFE 72222 - New York City
MT - Midnight
TEMPERATURES IN TRANSIT
PREICED, PRECOOLED IN CAR
STANDARD REFRIGERATION FAN SERVICE
TANGERINE SHIPPING TEST - ORLANDO, FLORIDA TO CHICAGO AND NEW YORK CITY, DECEMBER 1950
°F
90
80
70
60
50
40
30
6-hr. precooling period
Middle Quarterlength
Top Quarterlength
WFE 73174
Delayed in Transit
0
MT
1
MT
2
MT
3
MT
4
MT
5
MT
6
MT
DAYS IN TRANSIT

Figure 4

COMPARISON OF TEMPERATURES IN TRANSIT OF PRECOOLED AND NON-PRECOOLED LOADS
(PREICED, STANDARD REFRIGERATION, AND FAN SERVICE)

PRECOOLED IN CAR, 6 HRS. AVERAGE OF 8 TESTS

TANGERINE SHIPPING TESTS - CENTRAL FLORIDA TO NEW YORK CITY - JANUARY & FEBRUARY 1951

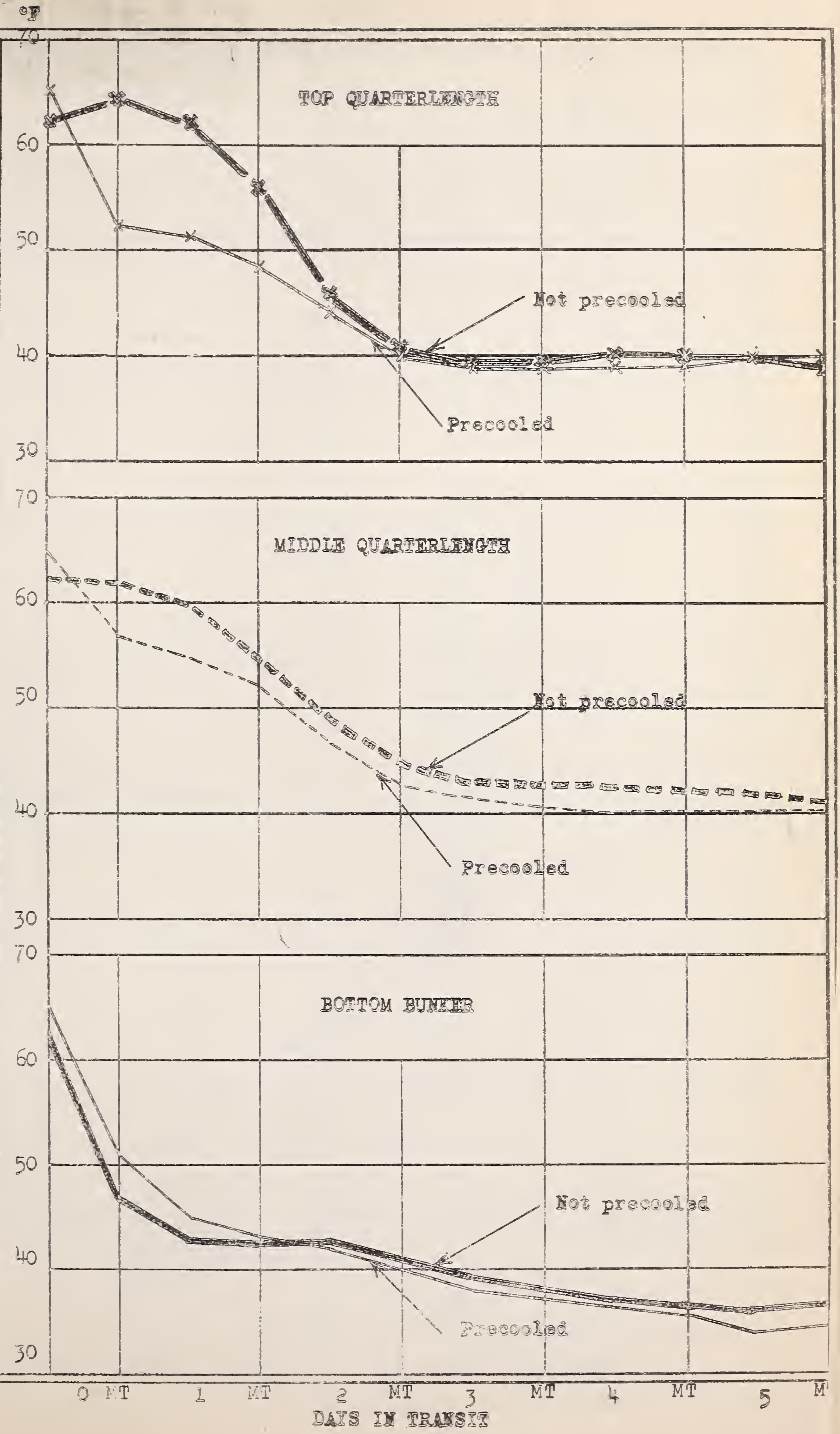
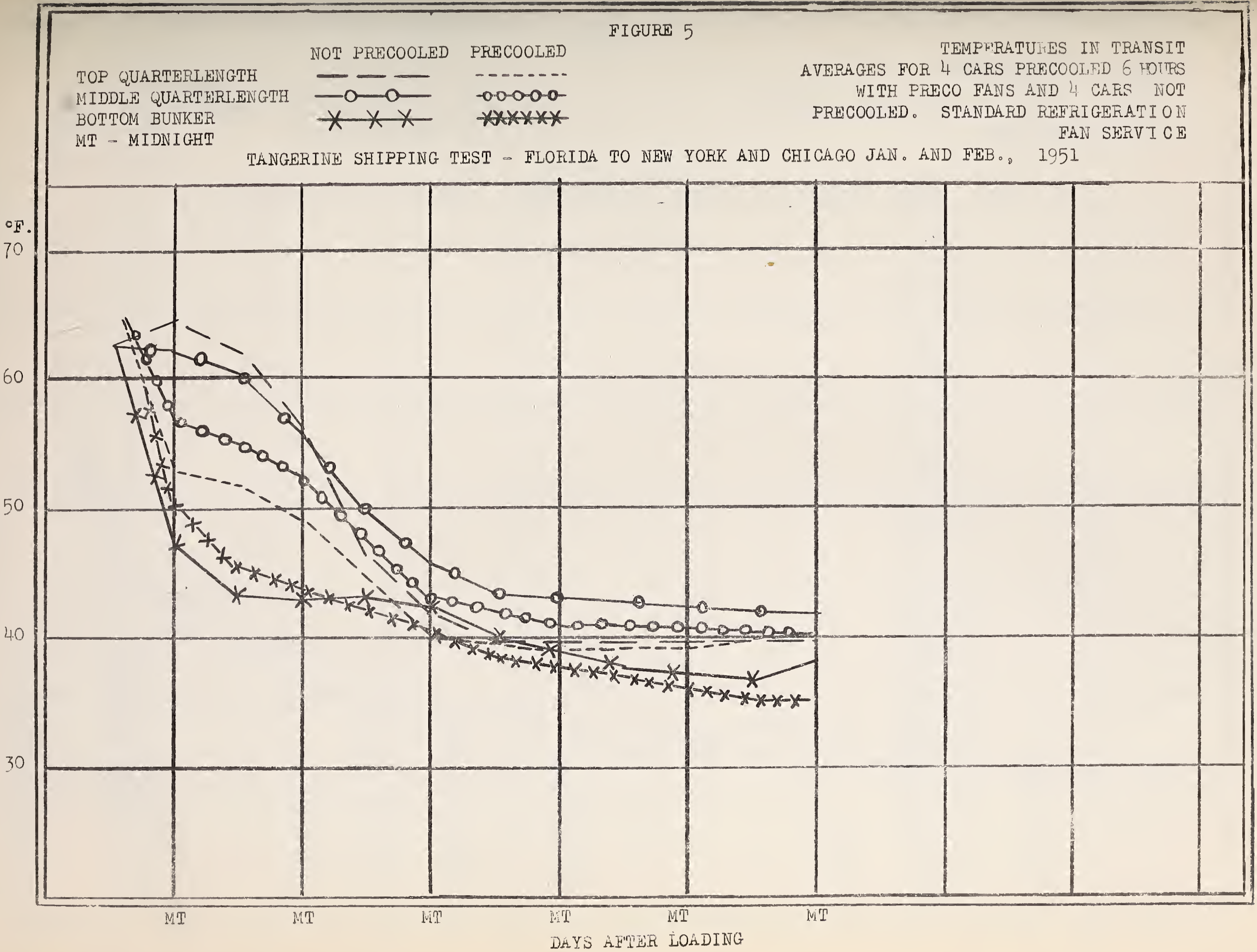


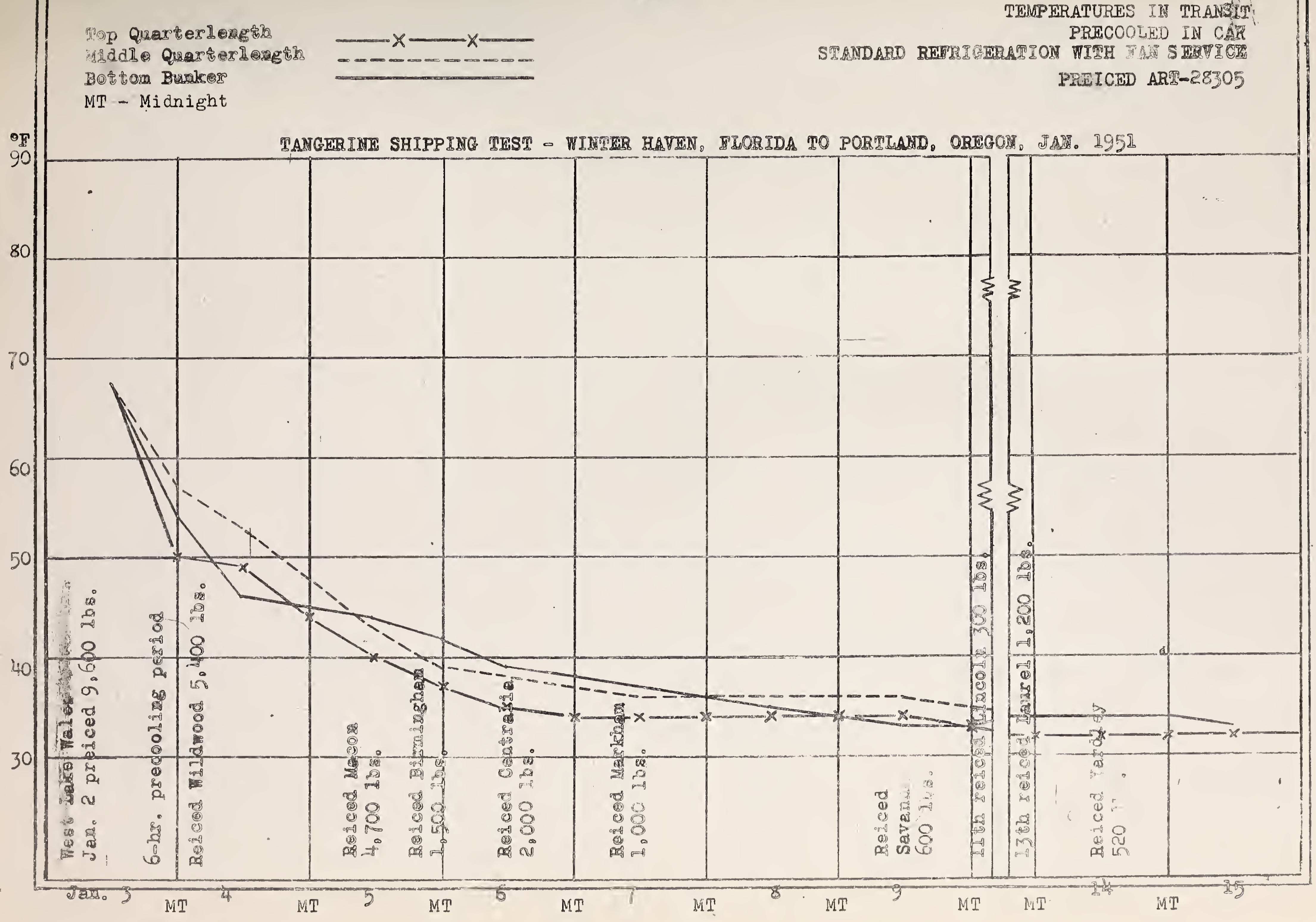
FIGURE 5



TEMPERATURES IN TRANSIT
AVERAGES FOR 4 CARS PRECOOLED 6 HOURS
WITH PRECO FANS AND 4 CARS NOT
PRECOOLED. STANDARD REFRIGERATION
FAN SERVICE

TANGERINE SHIPPING TEST - FLORIDA TO NEW YORK AND CHICAGO JAN. AND FEB., 1951

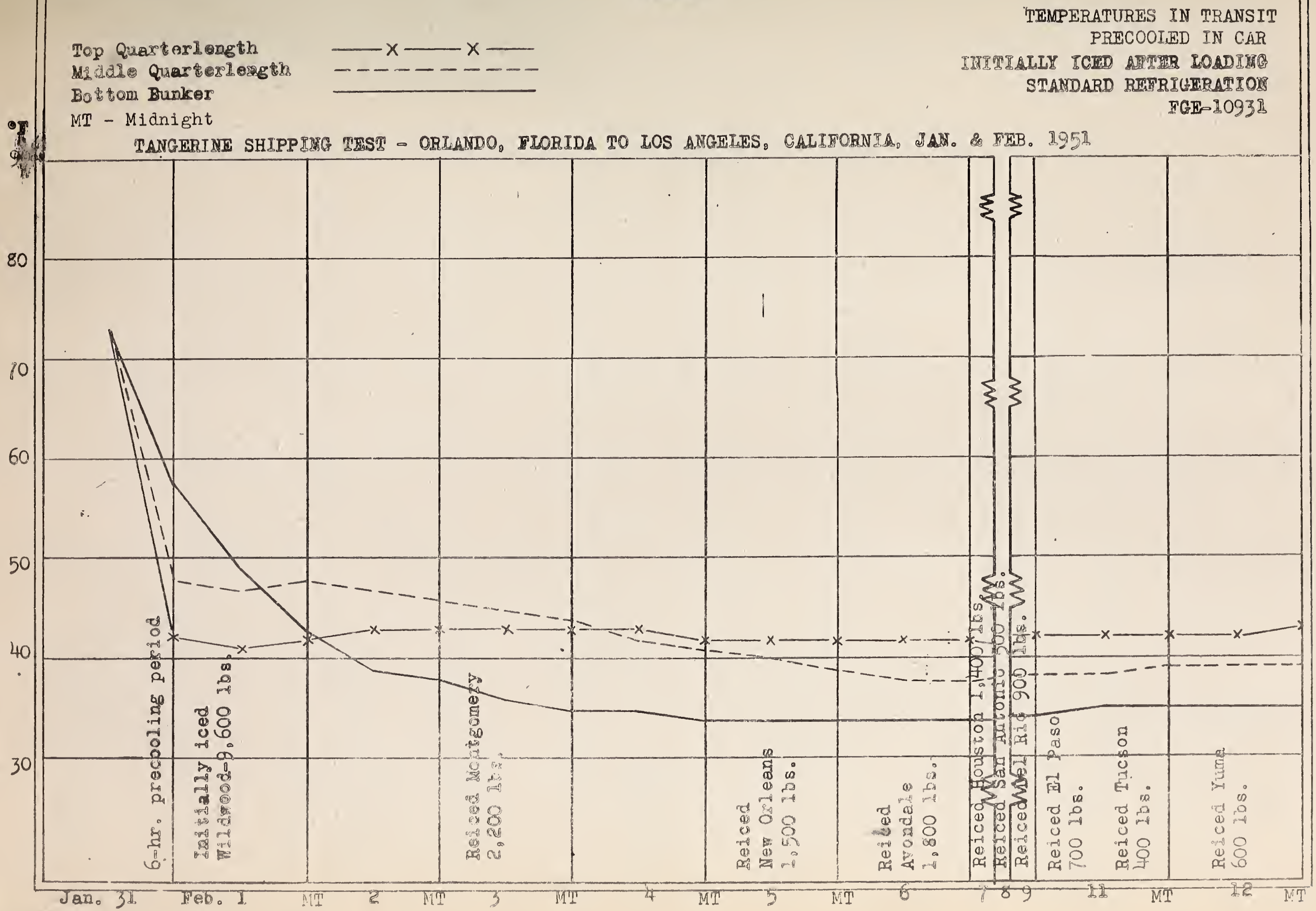
Figure 6



TEMPERATURES IN TRANSIT
PRECOOLED IN CAR
STANDARD REFRIGERATION WITH FAN SERVICE
PREICED ART-28305

TANGERINE SHIPPING TEST - WINTER HAVEN, FLORIDA TO PORTLAND, OREGON, JAN. 1951

Figure 7



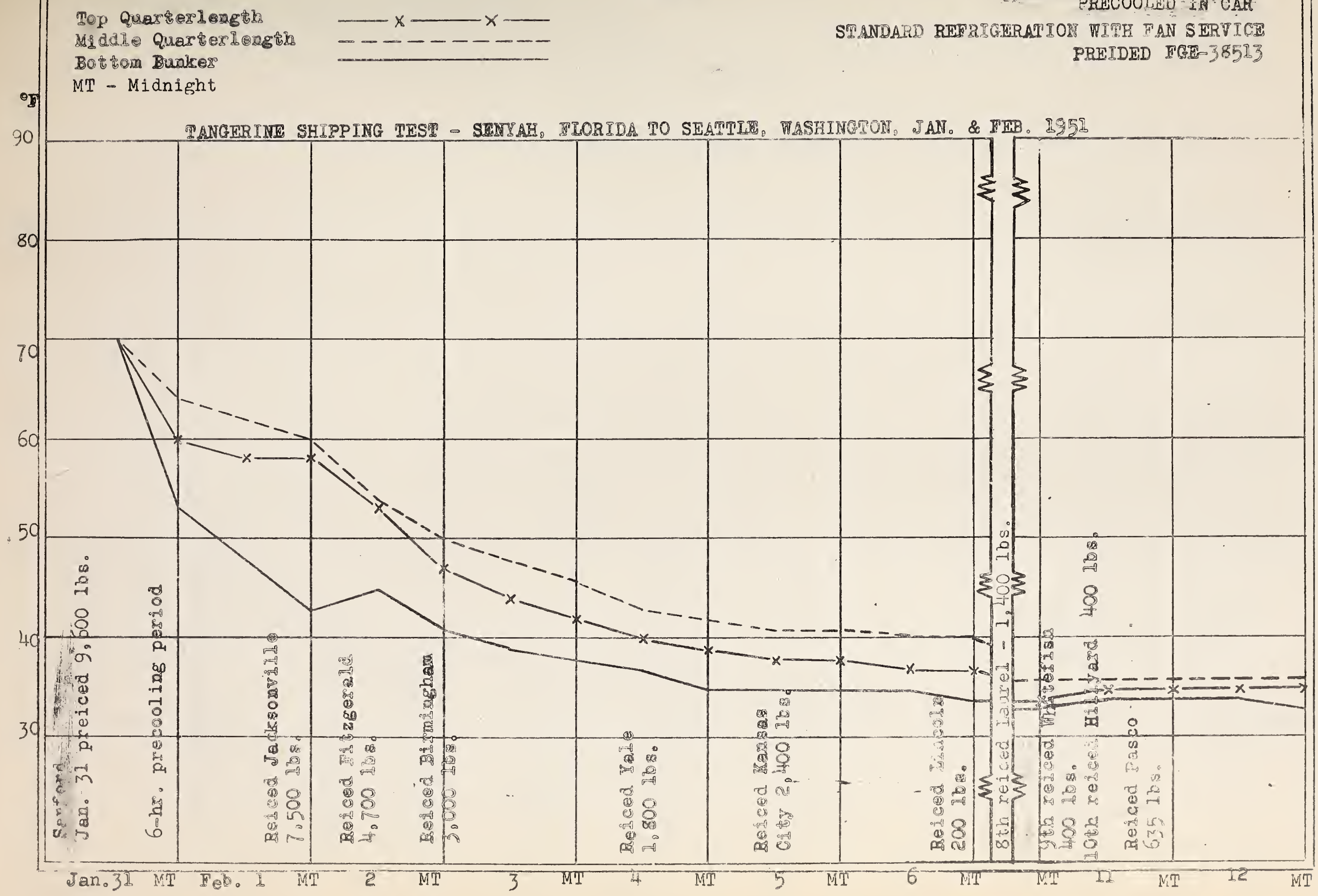
TEMPERATURES IN TRANSIT
PRECOOLED IN CAR
INITIALLY ICED AFTER LOADING
STANDARD REFRIGERATION
FGE-10931

TANGERINE SHIPPING TEST - ORLANDO, FLORIDA TO LOS ANGELES, CALIFORNIA, JAN. & FEB. 1951

Figure 8

TEMPERATURES IN TRANSIT
PRECOOLED IN CAR
STANDARD REFRIGERATION WITH FAN SERVICE
PREIDED FGE-38513

TANGERINE SHIPPING TEST - SENYAH, FLORIDA TO SEATTLE, WASHINGTON, JAN. & FEB. 1951



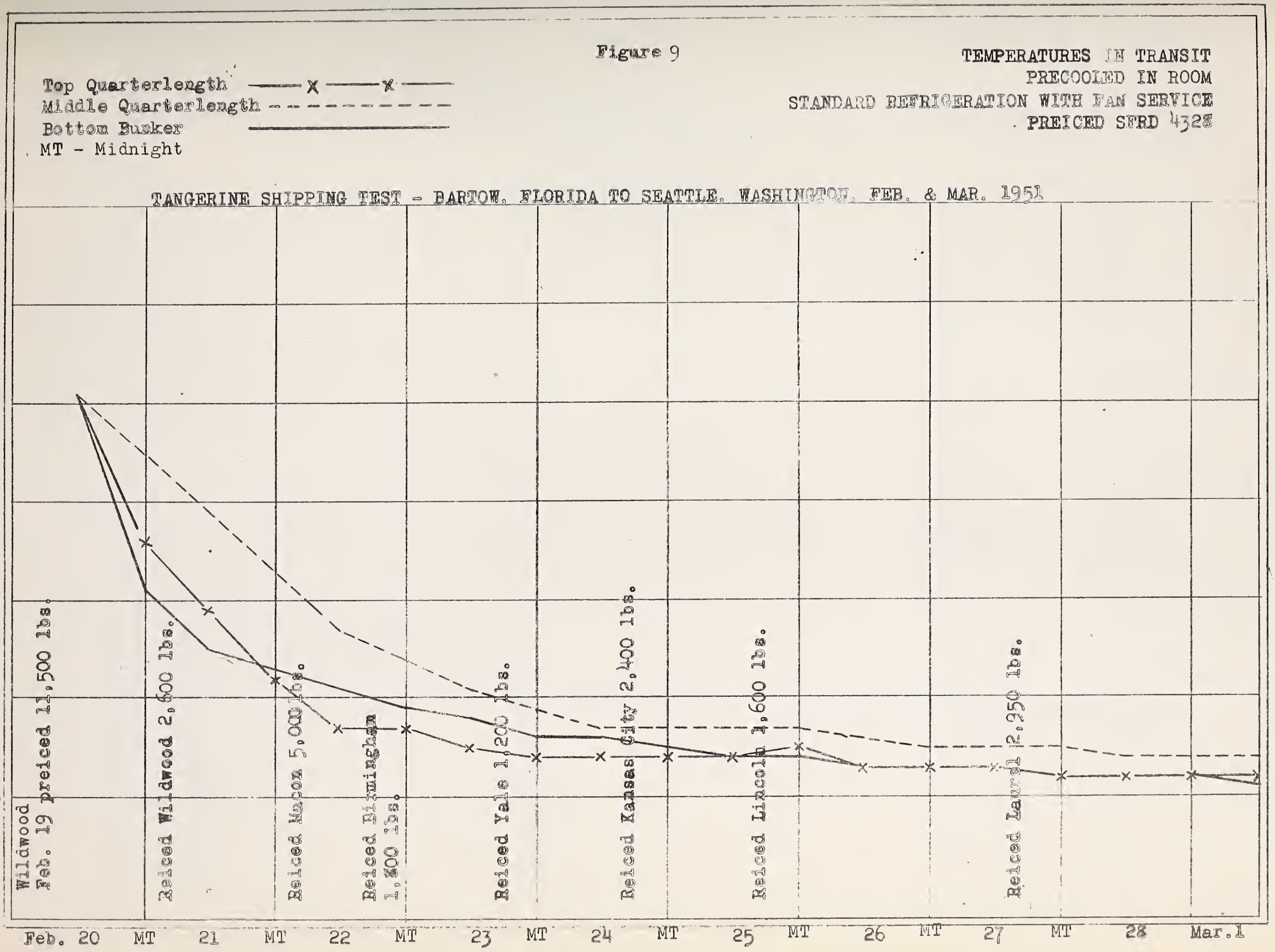
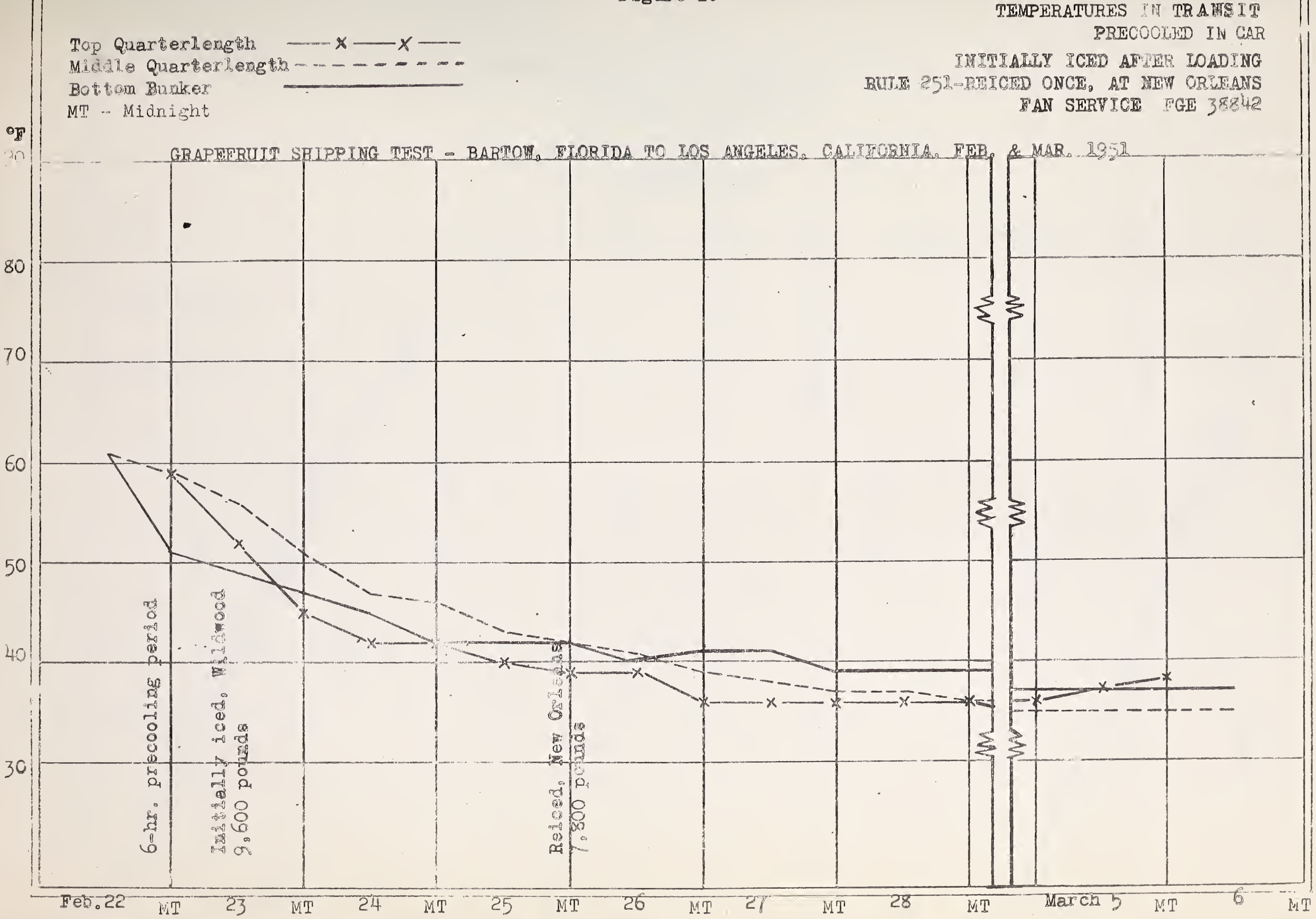


Figure 9

TEMPERATURES IN TRANSIT
PRECOOLED IN ROOM
STANDARD REFRIGERATION WITH FAN SERVICE
PREICED SFRD 4328

TANGERINE SHIPPING TEST - BARTOW, FLORIDA TO SEATTLE, WASHINGTON, FEB. & MAR. 1951

Figure 10



TEMPERATURES IN TRANSIT
PRECOOLED IN CAR
INITIALLY ICED AFTER LOADING
RULE 251-REICED ONCE, AT NEW ORLEANS
FAN SERVICE FGE 38842

GRAPEFRUIT SHIPPING TEST - BARTOW, FLORIDA TO LOS ANGELES, CALIFORNIA, FEB. & MAR. 1951

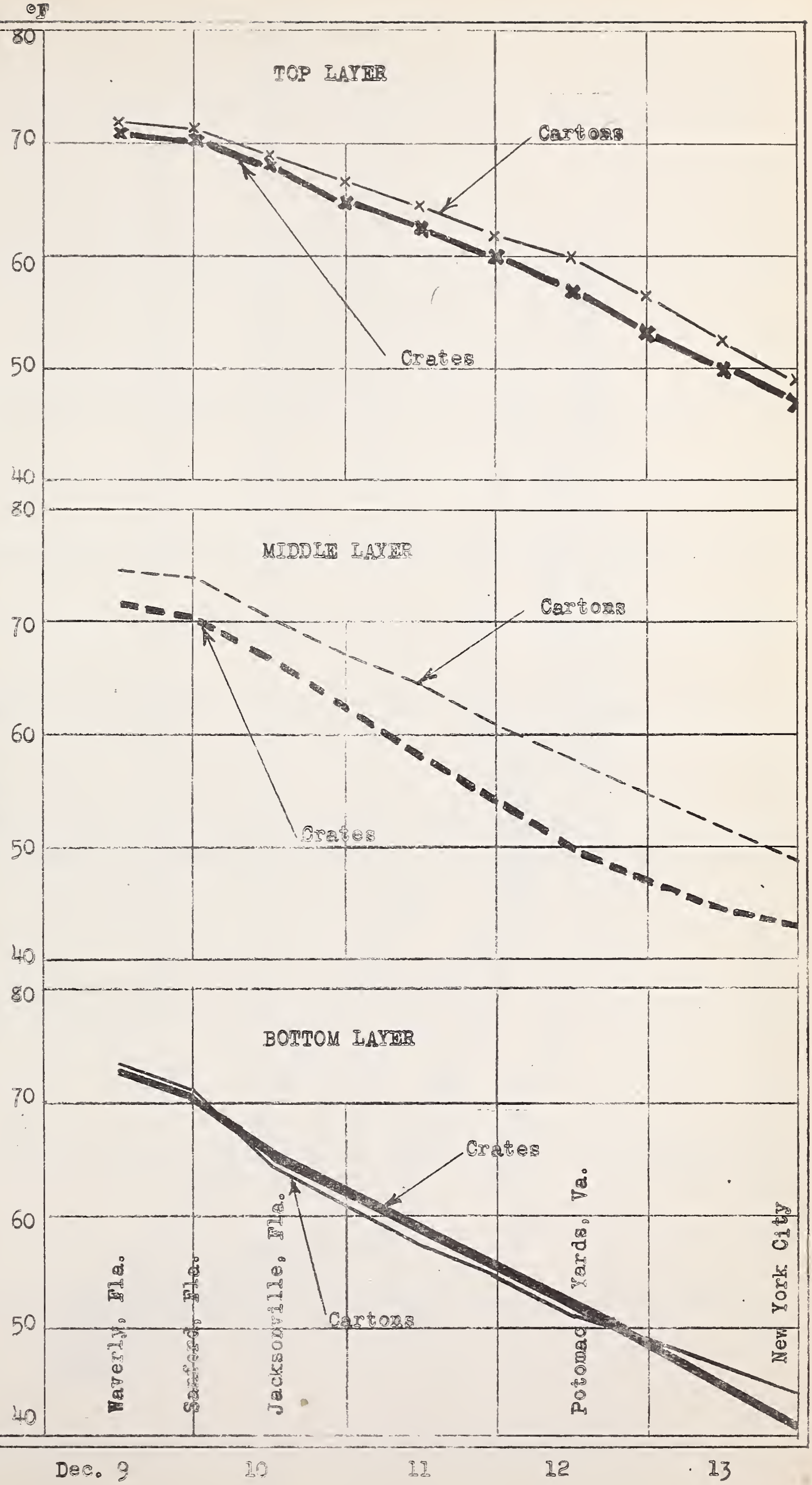


Figure 11
AVERAGE COMMODITY TEMPERATURES IN TRANSIT
COMPARISON OF CONTAINERS
STANDARD VENTILATION
ART-22507
WAVERLY, FLORIDA TO NEW YORK CITY
DECEMBER 1942

FIGURE 12

TEMPERATURES IN TRANSIT
PREICED, PRECOOLED IN CAR
STANDARD REFRIGERATION
FAN SERVICE, WFE 66469

TANGERINE SHIPPING TEST - DADE CITY, FLORIDA TO NEW YORK CITY, FEB., 1943